AMENDMENTS TO THE TITLE

Replace the title of the application with the following new title:

AMORPHOUS SELENIUM DETECTOR FOR ~~TOMOTHERAPY AND OTHER~~ IMAGE-GUIDED RADIOTHERAPY SYSTEMS

AMENDMENTS TO THE SPECIFICATION

Replace paragraph 2 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

The present invention relates generally to radiation detectors and more particularly to an amorphous selenium (a-Se) detector for use in medical and industrial applications for detecting high energy radiation, especially for use in ~~tomotherapy and other~~ image-guided radiotherapy systems.

Replace paragraph 14 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

What is needed is a relatively simple, inexpensive, and high efficiency radiation detector suitable for high-energy ~~tomotherapy and other~~ image-guided radiotherapy imaging applications

Replace paragraph 16 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

A detector assembly in accordance with a first embodiment of the present invention includes an enclosure with a top, bottom, at least two sides, and at least two ends. The detector assembly further includes a plurality of detector elements installed within the assembly. The plurality of detector elements are preferably vertically oriented within the detector assembly. Each of the detector elements preferably includes a substrate, a readout electrode layer deposited on at least one surface of the substrate, an amorphous selenium layer deposited on at least one surface of the readout electrode layer, and a high voltage electrode layer deposited on at least one surface of the amorphous selenium layer. The detector assembly is preferably positioned within <u>an</u> ~~a tomotherapy or other~~ image-guided radiotherapy machine such that the x-ray beam from the radiation source is directed downwardly and radially through the detector elements. And an electric field is applied transversely or perpendicularly across the detector elements. The readout electrode layer preferably includes a plurality of conductive strips and gaps that are oriented in various configurations, defining different embodiments that cover the whole radiation fan beam and line up with the x-ray source.

Replace paragraph 17 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

A detector assembly in accordance with a second embodiment of the present invention includes an enclosure with a top, bottom, at least two sides, and at least two ends. The detector assembly further includes a plurality of detector elements installed within the assembly. The plurality of detector elements are preferably arc-shaped and horizontally oriented within the detector assembly. Each of the detector elements preferably includes a substrate, a readout electrode layer deposited on at least one surface of the substrate, an amorphous selenium layer deposited on at least one surface of the readout electrode layer, and a high voltage electrode layer deposited on at least one surface of the amorphous selenium layer. The detector assembly is preferably positioned within an ~~a tomotherapy or other~~ image-guided radiotherapy machine such that the x-ray beam from the radiation source is directed downwardly and radially through the detector elements. And an electric field is applied transversely or perpendicularly across the detector elements. Again, the readout electrode layer preferably includes a plurality of conductive strips and gaps that are oriented in various configurations, defining different embodiments that cover the whole radiation fan beam and line up with the x-ray source.

Replace paragraph 20 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

The present invention has applications in image-guided radiotherapy ~~tomotherapy~~ systems, where imaging with the radiotherapy ~~tomotherapy~~ beams (the energy, intensity and other operating parameters of the beam can vary) is performed. The detection efficiency of the x-ray beams with the present invention is significantly improved, and thus the ability of resolving the objects is also significantly improved. The imaging functions in such a radiotherapy ~~tomotherapy~~ system include pre-treatment imaging for patient registration, in-treatment dynamic imaging for imaging guidance of the treatment, and post treatment imaging for dose reconstruction and treatment verification.

Replace paragraph 23 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

The detector assembly of the present invention not only offers superior performance in megavoltage applications but also offers great potential for savings in image-guided radiotherapy ~~tomotherapy~~ system manufacturing costs. The process of manufacturing detector elements and the mechanical assembly is much simplified, lowering cost. The main cost savings of the detector system is the electronics, which are also much simpler than prior art systems since the amplitude of the signals in the present invention are much larger.

Replace paragraph 27 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

1) The detector provides high detective efficiency above 50% at radiotherapy treatment ~~tomotherapy~~ energies, about 2 MeV in mean energy. This requirement forms the basis of attaining good spatial and contrast resolution. As a comparison, older Xe gas detectors for kV CT scanners, about 60 KeV in mean energy, operate with efficiencies on the order of 70% while modern solid-state detectors operate with efficiencies greater than 95%. Prior art portal image detectors used at MV energies only have efficiencies on the order of 1%.

Replace paragraph 30 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

4) The detector is two-dimensional with reasonably fine spatial resolution, and covers the largest beam settings in a radiotherapy ~~tomotherapy~~ system.

Replace paragraph 49 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

Referring now to the drawings, FIGS. 1-3 illustrate different views of an embodiment of a detector assembly 10 in accordance with the present invention. The detector assembly 10 is preferably housed in an enclosure 12 as shown in FIG. 1. The enclosure 12 is preferably arc-shaped and comprises a top 14, bottom 16, at least two sides 18, 20, and at least two ends 22, 24. A high voltage bus bar 26 extends from one of the sides 18 for connection to a high voltage source (not shown). A first dielectric element 28 preferably extends around and supports the bus bar 26. The top 14 and bottom 16 of the enclosure 12 aid in support and alignment of the detector assembly 10 when installed in ~~tomotherapy and other~~ image-guided radiotherapy systems. One example of a radiotherapy system in which such a detector assembly may be installed is the Hi·Art® treatment system available from TomoTherapy Incorporated of Madison, WI. FIG. 2 shows the detector assembly 10 of FIG. 1 with the top 14 of the assembly removed. A plurality of detector elements 30 are installed within the assembly 10. A second dielectric element 32 is preferably attached to the upper inside surface of one of the sides 20 opposite the side 18 having the first dielectric element 28 attached thereto for supporting and aligning the detector elements 30 between the first and second dielectric elements. The dielectric elements 28, 32 preferably include alignment features for locating the detector elements 30 within the assembly. In addition to the high voltage bus bar 26 and the plurality of detector elements 30, the enclosure 12 also houses signal conditioning and digitization electronics (not shown) for the

assembly. FIG. 3 is an enlarged detailed view of an upper comer portion of the detector assembly 12 shown in FIG. 2 taken from detail 3 of FIG. 2. FIG. 3 shows the first dielectric element 28 supporting the high voltage bus bar 26, a high voltage connection 34 for the high voltage bus bar 26, and a plurality of wire connections 36 from each of the detector elements 30 to the high voltage bus bar 26.

Replace paragraph 50 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

The detector assembly 10 preferably provides a large number of detector elements 30 compared to the current commercially available multi-row kV CT scanner detector systems. The detector elements 30 are preferably vertically oriented within the detector assembly 10. The detector elements 30 are preferably arranged coincidentally with a diverging x-ray beam. The divergence is preferably maintained by the tapering dielectric element 32 on one side of the detector elements. The dielectric elements 28, ~~30~~ 32 and the substrate of the detector elements 30 provide electric isolation between neighboring layers of the detector elements.

Replace paragraph 55 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

An analysis of the required tolerances is important to optimize cost and performance of the present invention. The resolution of the photoetching of the readout electrode layer is preferably maintained to 5 μm. The thickness of the amorphous selenium layer is preferably maintained to 50 μm. These tolerances will result in interaction volume variation of about 5%. This will not affect the performance because the signal from each detector element will always be normalized to the signal in that detector element in the absence of a patient on an ~~a in tomotherapy and other~~ image-guided radiotherapy system. The thickness of the high voltage electrode layer is preferably maintained to 25 μm. Local or global variations in the electrode layer or the substrate will not affect performance of the present invention because the thickness of the layers and the thickness of the separation will not influence the amount of charge collected, and small variations can be normalized out in the same fashion as for the active detector volume. The dielectric element thickness tolerance is preferably maintained to 2 μm. Random variations will not affect performance and systematic variations will be evident after all the layers are stacked and adjustments made. The tolerances of the components and layers can be easily maintained by modern machining and photoetching technology.

Replace paragraph 56 of U.S. Patent Application Publication No. 2006/0138339 with the following new paragraph:

The detector elements will be read out individually for every input radiation pulse with 16 bit integration analog-to-digital converters (ADCs). The digitizers of the ADCs are preferably equipped with a range selection bit to handle the big difference in the amplitudes of the output signals between the image and treatment mode of the ~~tomotherapy or other~~ image-guided radiotherapy machine, leading to an effective ADC range of 20 bits. At a typical linac repetition rate of 300 Hz, the data rate will be 25 k times 2B times 300/s=15 MB/second, a fairly modest rate compared to modern kV CT devices. As stated above, the analog outputs from the detection elements are preferably multiplexed to digitizers. At the typical ~~tomotherapy~~ linac repetition rate, a level of multiplexing of 500 to 1000 is possible, which reduces the number of digitizers from 25 to 50. This helps to reduce the manufacturing cost of the detector assemblies of the present invention substantially.